DOCUMENT RESUME

ED 065 596 TM 001 865

AUTHOR Collins, Kenneth
TITLE An Investigation of the Variables of Bloom's Mastery Learning Model for Teaching Mathematics.
PUB DATE Apr 72
NOTE 20p.; Paper presented at the Annual Meeting of the American Educational Research Association (Chicago, Illinois, April 1972)

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Academic Achievement; *Comparative Analysis; Control Groups; Educational Objectives; Experimental Groups; *Formative Evaluation; Grade 7; Grade 8; Hypothesis Testing; *Learning Processes; Statistical Analysis; *Student Testing
IDENTIFIERS Bloom (Benjamin S)

ABSTRACT

The purposes of this study were to examine and evaluate the importance of three variables of Bloom's mastery learning model. The variables studied were specification of objectives, use of diagnostic-progress (d-p) tests, and use of alternate resources. The study used four seventh grade and four eighth grade classes; each grade classes were pretested each semester on course objectives. There was no significant difference among the classes at the .25 level. Each class took chapter, unit, and semester (posttest) exams based on the objectives. The first semester eighth grade classes received four different treatments: no variables (control class), behavioral objectives, objectives and daily ungraded d-p tests with recommendations, objectives and d-p tests with recommendations that included alternate resources. There was a significant difference between the control class and each treatment class. Using second semester seventh grade classes, a comparison between a control class and a class using daily ungraded d-p tests with recommendations was significant at the .05 level. The results indicate that the use of either a list of specific objectives or d-p tests with recommendations is sufficient for a significant increase in student mastery of the objectives. The second semester seventh grade classes received four different treatments: no variables, general objectives, specific objectives, and daily ungraded d-p tests with recommendations. There was a significant difference between classes using specific and general objectives at the .10 level. (Author/DB)

An Investigation of The Variables of Bloom's Mastery Learning Model for Teaching Mathematics

Kenneth Collins
Purdue University

4.9
20p

ABSTRACT

The purposes of this study were to examine and evaluate the importance of three variables of Bloom's mastery learning model. The variables studied were specification of objectives, use of diagnostic-progress (d-p) tests, and use of alternate resources.

The study used four seventh grade and four eighth grade classes. The class size ranged from 24 to 31 with a mean of 27. The classes of each grade were pretested each semester on the course objectives. There was no significant difference among the classes at the .25 level. Each class took chapter, unit, and semester (posttest) exams based on the objectives.

The first semester eighth grade classes received four different treatments: no variables (control class), behavioral objectives, objectives and daily ungraded d-p tests with recommendations, objectives and d-p tests with recommendations that included alternate resources. The list of objectives indicated where they were discussed in the text and classwork. The d-p tests consisted of written questions based on the objectives studied in the previous class session. After a five to ten minute period to solve the problems, they were discussed and each student corrected his own paper. The students received recommendations for learning the objectives they had not mastered. Recommendations contained specific references to the text, classwork, and homework. The alternate resources included other texts, workbooks, SRA kits, games, and weekly small group meetings to review the results of the d-p tests. There was a significant difference between the control class and each treatment class. Using second semester seventh grade classes, a com-

parison between a control class and a class using daily ungraded d-p tests with recommendations was significant at the .05 level. The results indicate that the use of either a list of specific objectives or d-p tests with recommendations is sufficient for a significant increase in student mastery of the objectives. The use of alternate resources did not appreciably increase student achievement, indicating that the prescriptions based on the text and classwork were adequate.

The second semester seventh grade classes received four different treatments: no variables, general objectives, specific objectives, and daily ungraded d-p tests with recommendations. The list of general objectives was similar to a table of contents. There was no significant difference at the .25 level between the control class and the class using general objectives. There was a significant difference between the classes using specific and general objectives at the .10 level. The class using specific objectives also performed significantly better than the control class at the .05 level. The results confirm the usefulness of specific objectives and imply that general objectives of the form used have little effect on student achievement.

The Importance of Formative Evaluation

Formative evaluation is one of the key factors in the mastery learning model proposed by Bloom.(2) This section will discuss the literature and research that relate to formative evaluation and mastery learning.

Formative evaluation was first described by Scriven(7)as the evaluation of the instructional process while it is still occuring. Bloom(2) stated that formative evaluation provides feedback to the student and teacher on student process through a unit. It helps locate errors in the structure of the unit so that remedial alternate instruction can be prescribed and used. Sullivan(7)stated that this helps the teacher to identify the materials and procedures that increase the effectiveness of the instruction. Thus after using the necessary remedial instruction which is suited for his needs, the student is prepared to learn subsequent tasks.

Research Using Formative Evaluation

A four year longitudinal study by Thompson(8)investigated arithmetic and algebra instruction. Each student in the experimental group worked alone. He was given a diagnostic pretest to determine if he had previously mastered the material of the unit. If he had, he continued with the pretest of the next unit. When the pretest indicated lack of student mastery, remedial drill material was provided and a final test was given to determine if the remedial work was successful. Mastery of each unit was required before advancing to the next unit. The control class used the normal textbook, lesson assignments, and recitation method. In one study, the experimental group gained 1.4 years of arithmetic achievement compared to .4 year for the control group as measured

by standard arithmetic tests over a ten week period. A second study reported an average gain of 2.6 years of arithmetic achievement in one year for a seventh grade class. The researcher concluded that the diagnostic exams and remedial individual instruction were effective since students did not waste time on previously mastered material, did not have to wait for the rest of his class, and mastered each topic before advancing to the next one.

Mayo(5) and his associates examined a six week college course that used weekly formative tests accompanied by individual and small group help as needed. 65% of the students mastered the material as measured by the final exam as compared with 3% mastery on an analogous exam the previous year when formative tests were not used. The feedback provided by the formative tests was important and helped the student in the individual and group sessions.

A study by Airasian(1) examined a ten week college course that used biweekly ungraded d-p tests. The students who did not master the unit covered by the test were given alternate learning resources to overcome their difficulties. Commonly missed items on the d-p tests indicated a weakness in the instruction which was corrected before starting a new unit. 80% of the students achieved mastery as measured by the final exam compared with 30% on an analogous test the previous year when d-p tests were not used.

A similar study by Bloom(2) used d-p tests after each unit and alternate resources, including small student groups of four students or less to review the d-p tests and help overcome the difficulties pointed out by the tests. 80% of the students achieved mastery as measured by the final exam compared with 20% on an analogous test the previous year when d-p tests were not used. The same procedures were used the following year and 90% of the students achieved mastery.

Moore, Mahan, and Ritts(6) examined three college courses that used

instructional material that students could use on their own. Students were tested at the completion of each unit and were directed to additional instructional material and unit tests until they achieved mastery. 80% of one experimental group achieved mastery compared with 60% of the corresponding control group. The means of the other two experimental groups were half a standard deviation above the control group. The authors could not attribute the success of their method to one particular variable. It depended on the student.

A study by Collins (3) compared two college mathematics classes. The experimental group was given a list of the objectives for each unit and a diagnostic problem each session that was based on the objectives studied the previous session. The control class was taught in a normal recitation section without using a list of objectives or a diagnostic test. 75% of the experimental group compared with 30% of the control group achieved mastery as measured by the final examination based on the course objectives. The researcher believed that both the specification of objectives and the use of diagnostic tests were important for increased student mastery.

A study by Kersh (4) used fifth grade mathematics classes to examine the effectiveness of diagnostic tests. After completing a unit over a period of three or four weeks, the students took a diagnostic test and were directed to alternate resources on the basis of their test performance. After a week of using the resources, the students were retested. This was a reinforcement to those students who had used the resources to correct their errors. The increase in mastery as measured by the criteria tests ranged from 19% to 75% for the advantaged class to 0% to 20% for the disadvantaged class. Thus the disadvantaged experimental group performed as well as the advantaged control group.

Summary

The data show that the use of mastery learning strategies with formative evaluation can significantly increase the percentage of student mastery. It can be successful for different subjects, grades, and student backgrounds. The use of diagnostic tests to give feedback to the students and teacher and to prescribe remedial help to the student is important. The results from the section describing the affective and cognitive consequences of successful achievement give additional support for the use of formative evaluation and mastery learning strategies.

DESIGN AND PROCEDURES

The main objectives of this study were to examine the effect on mastery learning resulting from:

1. Providing specific objectives.
2. Providing general objectives.
3. Giving diagnostic-progress tests with recommendations.
4. Giving specific objectives and diagnostic-progress tests.
5. Giving specific objectives, diagnostic-progress tests, and alternate resources.

The first objective was examined twice by comparing a control class that did not use any of the variables with a class that received only specific objectives. This was done the first semester with classes I and II of the eighth grade and the second term with classes V and VII of the seventh grade (see Design).

The second objective was examined by comparing a control class with a class that received only general objectives. This was done the second semester with classes V and VI of the seventh grade.

The third objective was examined by comparing a control class with a class that was given only diagnostic-progress tests. This was done the second semester with classes V and VIII of the seventh grade.

The fourth objective was examined by comparing a control class with a class that received only specific objectives and d-p tests. This was done the first semester with classes I and III of the eighth grade.

The fifth objective was examined by comparing a control class with a class that received specific objectives, d-p tests, and alternate resources. This was done the first semester with classes I and IV of the eighth grade.

Explanation of the Variables and Conditions

The three variables examined were specification of objectives, use of diagnostic-progress tests, and use of alternate resources. The objectives were specified in two ways: either specific (behavioral) objectives or general objectives (similar to a table of contents).

The diagnostic-progress tests were based on the specific objectives studied during the previous day or week, depending on how often the tests were given. Normally one or two written questions were asked at the beginning of the class period and the students were given sufficient time (usually between five and fifteen minutes) to work on the problems and write their solutions. The questions were then discussed and any difficulties that the students were having were treated. There were specific recommendations given to the students for each question. They included references to the text, classwork, handouts, and homework where the student could find a discussion or an explanation of the objective tested by that question. Thus if a student had any difficulties with a problem, he could use the recommendations to help him restudy the material. In effect this was a prescription to help him cure his problems that were not resolved to his satisfaction in class. The decision to

restudy the objectives was the student's and he was given any further assistance asked for.

The control classes were taught without using any student list of objectives, d-p tests, or alternate resources. They used the text, classwork, and homework to study the material. They took the same pretests, unit tests, and posttests as the treatment groups. Although the control groups did not use any of the variables, the instruction they received probably benefited from having their teacher instruct the treatment classes in the same material.

Design

The study used students attending the seventh and eighth grades of junior high school. The students were already grouped into classes and random assignment of students to class could not be assumed. Thus the design required a pretest as well as a posttest so that any initial class differences could be incorporated into the analysis of the data.

The design used eight different classes, four from each grade. Each class was given a pretest and a posttest based on the objectives of the material studied that semester. The data were analyzed using an analysis of covariance with the pretest score as the covariate and the posttest score as the variate.

There were two distinct experiments which will be described below:

First Semester Eighth Grade Classes

Class	Variables and Conditions	Number of Students
I	None (control group).	29
II	Specific objectives.	31
III	Specific objectives and d-p tests (daily, ungraded, with recommendations).	24
IV	Specific objectives, d-p tests (daily, ungraded, with recommendations), and alternate resources.	25

An analysis of variance was performed using the results of the posttest. An analysis of covariance was performed using the results of the pretest and posttest with the pretest score as the covariate and the posttest score as the variate. The level of significance for both analyses was $\alpha = .05$.

Using the means of the class scores on the pretest and posttest and the regression coeficient obtained from the data, adjusted posttest means for each class were calculated using the procedure described in Winer (9) Three comparisons were made using the adjusted treatment means; class I was compared with each of the other classes. The level of significance used for these tests was $\alpha = .05$.

Second Semester Seventh Grade Classes

Class	Number of Students	Variables and Conditions
V	25	None (control class).
VI	29	General objectives.
VII	28	Specific objectives.
VIII	26	d-p tests (daily, ungraded, with recommendations).

An analysis of variance was performed using the results of the posttest. An analysis of covariance was performed using the results of the pretest and posttest with the pretest score as the covariate and the posttest score as the variate. The level of significance for both analyses was $\alpha = .05$.

Using the mean class scores on the pretest and posttest and the regression coefficient obtained from the data, adjusted posttest means for each class were calculated. Four comparisons were made using the adjusted treatment means; class V was compared with every other class and classes VI and VII were compared. The level of significance used for the last test was $\alpha = .10$. The level of significance for the test

between classes V and VI was $\alpha = .25$. The level of significance for comparing class V with classes VII and VIII was $\alpha = .05$. The test between classes V and VI uses a large value for α for the experiment is best served if there are no significant differences between the adjusted mean scores. Thus, to be safe, we should allow any sizable differences between the mean scores to be called significant. We want to avoid a type 2 error, namely not rejecting the hypothesis when it should be rejected. Using a large value for α decreases the probability of making a type 2 error.(9)

CONCLUSIONS, IMPLICATIONS

To test the objectives, the following hypotheses were formulated:

I. a) There is no significant difference between the adjusted mean scores on the posttest for a control class using none of the variables and a class using only specific objectives.

b) There is no significant difference in the adjusted mean scores on the posttest between a control class and a class using only daily, ungraded d-p tests with recommendations.

c) There is no significant difference in the adjusted mean scores on the posttest between a control class and a class using daily, ungraded d-p tests with recommendations and specific objectives.

d) There is no significant difference in the adjusted mean scores on the posttest between a control class and a class receiving specific objectives, daily, ungraded d-p tests, with recommendations, and alternate resources.

Conclusions

The purpose of this hypothesis was to examine the effect of using specific objectives, d-p tests, and alternate resources. This was the key hypothesis of the study. The first semester eighth grade classes and classes V and VIII of the second semester seventh grade classes were used to test hypothesis I. An analysis of variance indicated that the posttest means of the first semester eighth grade classes were significantly different. An analysis of covariance also found the adjusted posttest means to be significantly different. Each treatment class was compared with the control class and the difference between the adjusted posttest means was significant in each case. Thus it appears that the use of specific objectives or d-p tests is sufficient for a significant effect when compared with a control class. Naturally using both variables and including alternate resources increases the effect.

Implications

The results of the tests of hypothesis I were very interesting. As mentioned in previously, the variables have a certain hierarchy. To use alternate resources, it is necessary to have some form of diagnostic testing. To use diagnostic tests, it is necessary to know what is being diagnosed, i.e.: the objectives must be specified. This study concluded that the use of specific objectives is sufficient for a significant increase in mastery learning as measured by the posttest. Specification of objectives is perhaps the most difficult variable to properly prepare. It requires a detailed analysis of the material and content of the course. It can be the basis for a diagnosis of both student and instruction difficulties. Perhaps this explains why it has a significant effect when it is utilized.

TABLE I

Statistical Summary of the Four Comparisons Between Adjusted Posttest Means of the First Semester Eighth Grade Classes and Classes V and VIII of the Second Semester

Class	n	$\bar{X}$	$\bar{Y}$	$\bar{Y}'$		
I	29	81.41	76.14	77.01		
II	31	84.32	82.68	82.65	$\beta = .31$	
III	24	84.38	84.92	84.87	$\bar{X}_{tot} = 84.23$	
IV	25	87.24	85.96	85.01	$\bar{Y}_{tot} = 82.18$	
V	25	77.68	74.64	74.75	$\beta = .37$	
VIII	26	80.00	82.00	81.26	$\bar{X}_{tot} = 77.99$	$\bar{Y}_{tot} = 78.06$

Control class vs class using specific objectives.

$H_0: \mu_1^{\dot{}} = \mu_2^{\dot{}}$

$H_1: \mu_1^{\dot{}} \neq \mu_2^{\dot{}}$

$F_{.05}(1, 103) = 3.95 < F_{obs} = 4.06.$

Reject H_0 for $\alpha = .05$

Control class vs class using d-p tests.

$H_0: \mu_5' = \mu_8'$

$H_1: \mu_5' \neq \mu_8'$

$F_{.05}(1, 103) = 3.95 < F_{obs} = 5.61.$

Reject H_0 for $\alpha = .05$.

TABLE I (Continued)

Control class vs class using specific objectives and d-p tests.

$H_0: \mu_1' = \mu_3'$

$H_1: \mu_1' \neq \mu_3'$

$F_{.05}(1, 103) = 3.95 < F_{obs} = 7.89.$

Reject H_0 for $\alpha = .05$.

Control class vs class using specific objectives, d-p tests, and alternate resources.

$H_0: \mu_1' = \mu_4'$

$H_1: \mu_1' \neq \mu_4'$

$F_{.05}(1, 103) = 3.95 < F_{obs} = 8.17.$

Reject H_0 for $\alpha = .05$.

Once the objectives have been specified, the construction of the d-p tests is not difficult. Each objective can generate questions that test student mastery. This study concluded that d-p tests with recommendations significantly increased mastery learning as measured by the posttest. The increase in mastery learning due to using d-p tests in addition to specific objectives and the relative ease of constructing d-p tests once the objectives have been specified would imply that the additional use of d-p tests is worth the effort.

The use of alternate resources in addition to specific objectives and d-p tests did have a significant effect but one that was not very different from the effect of using just specific objectives and d-p tests. One possible explanation is that after an analysis of the text and assignments was made using the list of specific objectives, handouts were used to strengthen the instruction where it appeared to be weak. This may be considered an alternate resource, but it was a standard part of the recommendations for the d-p tests. The handouts often elaborated some of the more difficult sections of the course. Thus they may have been more pertinent than the alternate resources, such as other texts, workbooks, kits, that were offered. These alternate resources were not widely used since their approach to the material was somewhat different from the class notes and text and the students found this somewhat confusing.

Another alternate resource, the use of small groups to review the results of the d-p tests, was only partially successful. The students (and their instructor) may have been too young or inexperienced to use this technique effectively. It would seem that a careful balance of

mathematical proficiencies, social compatibility, and work habits would be important for the proper functioning of these groups. Unfortunately, this study did not attempt such a balanced composition of groups and allowed them to form with little supervision. Some of the resulting groups did not function well.

It would appear that if the course has good reference material and clearly specified objectives, then the use of handouts to supplement the weaker areas of the instruction may be a sufficient alternate resource. Group work can be effective, but it seems that attention must be paid to their formation, orientation, and supervision.

Hypothesis II

(a) There is no significant difference in the adjusted mean scores on the posttest between a control class and a class using only general objectives.

(b) There is no significant difference in the adjusted mean scores on the posttest between a control class and a class using only specific objectives.

Conclusions

The purpose of this hypothesis was to examine the effect of using general objectives and compare the use of general and specific objectives. This hypothesis used the seventh grade classes of the second semester. An analysis of variance indicated that there was a significant difference among the posttest mean scores. An analysis of covariance indicated that there was a significant difference among the adjusted posttest means. A comparison test was performed between the control class and a class receiving only general objectives. No significant difference was found between the adjusted posttest means. Thus it does

not appear that the use of general objectives has a significant effect on mastery learning as measured by the posttest. A comparison test was also performed between the classes using only general objectives and only specific objectives. A significant difference was found between the adjusted posttest means in favor of specific objectives. Thus it appears that the use of specific objectives was significantly more effective than the use of general objectives. A third comparison test was performed between the control class and the class using only specific objectives. A significant difference was found. This agrees with the results of the section of this chapter discussing hypothesis II.

Implications

General objectives describing the content of the course are relatively easy to write but do not seem to be effective. Thus specific objectives appear to be preferable.

Summary

The results of this study suggest the following conclusions:

1. The use of specific objectives and/or d-p tests, or specific objectives and d-p tests with alternate resources had a significant effect on mastery learning when compared with the use of none of these variables. The use of specific objectives with d-p tests appeared to be the optimal choice.

2. The use of general objectives did not have a significant effect on mastery learning when compared with the use of no objectives. The use of specific objectives had a significant effect when compared with the use of general objectives. If objectives are used, they should be specific objectives.

TABLE II

Statistical Summary of the Comparisons Between the Adjusted Posttest Means of the Second Semester Seventh Grade Classes.

Class	n	$\bar{X}$	$\bar{Y}$	$\bar{Y}'$	
V	25	77.68	74.64	74.75	
VI	29	75.90	74.62	75.39	$\beta = .37$
VII	28	78.57	81.04	80.84	$\bar{X}_{tot} = 77.99$
VIII	26	80.00	82.00	81.26	$\bar{Y}_{tot} = 78.06$

Comparison between control class and class using general objectives.

$H_0: \mu'_6 = \mu'_5$

$H_1: \mu'_6 \neq \mu'_5$

$F_{.25}(1, 103) = 1.34 > F_{obs} = 0.05.$

Do not reject H_0 for $\alpha = .25$.

Comparison between classes using specific objectives and general objectives.

$H_0: \mu'_6 = \mu'_7$

$H_1: \mu'_6 \neq \mu'_7$

$F_{.10}(1, 103) = 2.76 < F_{obs} = 3.93.$

Reject H_0 for $\alpha = .10$.

TABLE III

Summary of Comparisons and Results as Measured by the Posttest.

Comparison	α-level	Result
control vs general objectives	.25	no significant difference
control vs specific objectives	.05	significant difference
control vs d-p tests	.05	significant difference
control vs specific objectives & d-p tests	.05	significant difference
control vs specific objectives & d-p tests with alternate resources	.05	significant difference
general objectives vs specific objectives	.10	significant difference

TABLE IVI

Summary of Mastery Achievement of Each Class as Measured by the Posttest

Treatment	Grade	Semester	Class	Percentage of Class Achieving Mastery
control	8	1	I	41%
control	7	2	V	40%
general objectives	7	2	VI	45%
specific objectives	7	2	VII	61%
specific objectives	8	1	II	61%
d-p tests with recommendations	7	2	VIII	69%
specific objectives and d-p tests	8	1	III	75%
specific objectives and d-p tests with alternate resources	8	1	IV	80%

BIBLIOGRAPHY

1. Airasian, Peter. "An Application of a Modified Version of John Carroll's Model of School Learning," Unpublished Master's Thesis, University of Chicago, 1967.

2. Bloom, Benjamin, S. "Learning for Mastery," UCLA-CSEIP Evaluation Comment, I, No. 2 (May, 1968).

3. Collins, Kenneth. "A Strategy for Mastery Learning in Freshman Mathematics," Unpublished Research, Purdue University, 1969.

4. Kersh, Mildred. "A Strategy for Mastery Learning in Fifth Grade Arithmetic." Unpublished Doctoral Dissertation, University of Chicago, 1970.

5. Mayo, Samuel, Ruth Hunt, and Fred Trommel. "A Mastery Approach to the Evaluation of Learning Statistics," Proceedings, Annual Convention, NCME, (February, 1968), 53.

6. Moore, John W., J. M. Mahan, and C. A. Ritts. "An Evaluation of the Continuous Progress Concept of Instruction with University Students," Abstracts, Annual Meeting, AERA, (February, 1968), 341-342.

7. Popham, W. James, et. al.. Instructional Objectives. AERA Monograph 3. Chicago: Rand McNally and Company, 1969.

8. Thompson, R. B. "Diagnosis and Remedial Instruction in Mathematics," School Science and Mathematics, XLI, No. 355 (February, 1941), 125-128.

9. Winer, B. J. Statistical Principles in Experimental Design. New York: McGraw Hill Book Company, 1962.